# §44. Development of Low Z Cone for Effective Additional Heating

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Fast ignition is one of the proposed ways to achieve high fusion energy gain in inertial fusion research. For a successful ignition, it is necessary to transport the energy of fast electrons to the imploded core effectively. However, many researchers have reported that fast electrons were diverged more than expected[1, 2]. In addition, it is concerned that fast electrons are scattered by high-Z plasma generated from gold cone target. This may cause the drop of the energy coupling of the heating laser to the fast electrons[3]. Therefore, low-Z materials, such as diamond like carbon (DLC)[4, 5] and aluminum, are drawing attention as cone materials. In this study, I develop these advanced cone targets using DLC.

DLC layer were prepared on the brass conical bar by using plasma–based ion implantation and deposition (PBIID) system. The schematic diagram of the system is shown in Fig. 1. In this system, the RF for plasma generation is supplied to the substrate together with a negative high-voltage pulse (-10kV) for ion implantation through a single electric feed-through. Argon and methane plasma is used for target cleaning before deposition. Acetylene gas or toluene vapor is introduced to the chamber after this cleaning. Detailed parameters are shown in Table I.

Several preparation conditions were tested in order to optimize the deposition condition. The results are shown in Table II and Table III. X-mark means DLC film was not deposited or broken as it cools down. Numerical value shows the thickness of the deposited film. The thickness was measured by using a step gauge and a laser microscope. It is found that the low pressure and low RF pulse power condition is suitable for film deposition. In the case of 0.25 Pa and 300 W, the thickness of films using toluene is about 3 times larger than that of films using acetylene. This means that toluene has an advantage for thick film deposition. Other properties such as crystallinity will be measured in the near future.

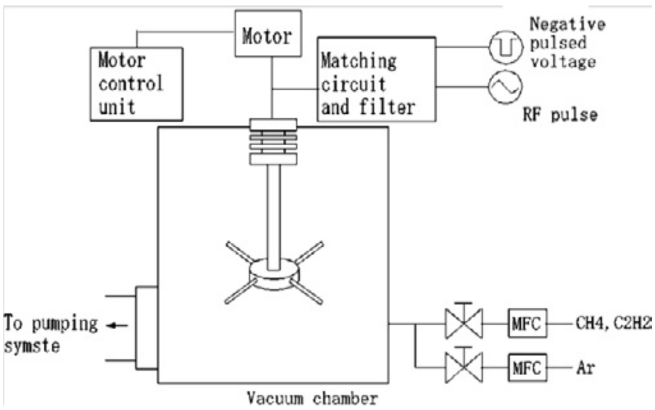


Fig. 1. Schematic diagram of PBIID system.

Table I. Deposition process.

| | Pretreatment | Deposition | |
|---|---|---|---|
| Gaseous species | Argon/Methane | Acetylene | Toluene |
| Flow (cc/min.) | 10/30 | 50 | 30 |
| Time (min.) | 30 | 180 | 180 |
| Frequency (kHz) | 0.5 | 0.5 | 1 |
| Pulse width of negative voltage (μs) | 5 | 3 | 3 |

Table II. Thickness of deposited films using acetylene. (units: μm. X-mark means that films were not deposited or broken.)

| Pressure (Pa) \ RF pulse power (W) | 100 | 200 | 300 | 400 | 500 |
|---|---|---|---|---|---|
| 1.50 | | | × | | |
| 1.25 | | | × | | |
| 1.00 | 1.3 | 0.7 | 1.2 | × | × |
| 0.50 | | | 0.8 | | |
| 0.25 | | | 1.2 | | |

Table III. Thickness of deposited films using toluene. (units: μm. X-mark means that films were not deposited or broken.)

| Pressure (Pa) \ RF pulse power (W) | 100 | 200 | 300 | 400 | 500 |
|---|---|---|---|---|---|
| 1.50 | | | × | | |
| 1.25 | | | | | |
| 1.00 | | | × | | |
| 0.50 | | | 0.8 | | |
| 0.25 | 4.5 | | 3.2 | | |

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